Tracking at BESIII and possible input for SPD

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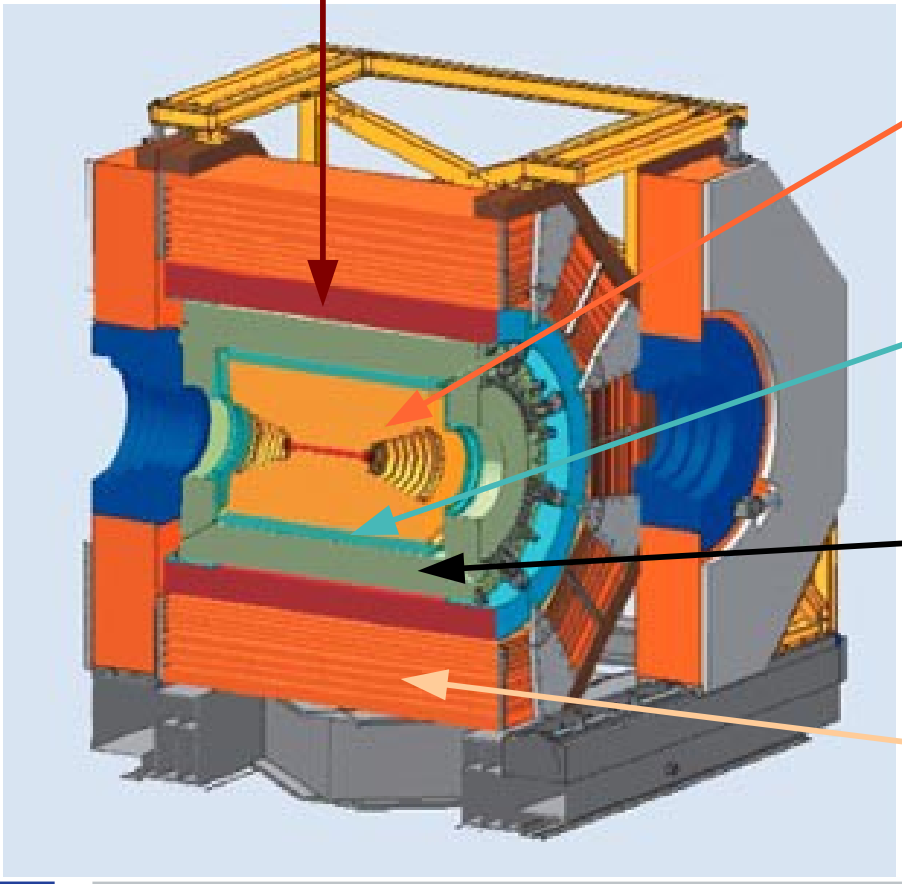
BESIII detector

Superconducting magnet: **1 T**

NIM A614, 345(2010)



MDC:
- Spatial resolution: σ_{xy} **= 120μm**
- Momentum resolution:**0.5% @ 1GeV**
- **dE/dx** resolution: 6%

TOF (double layer scintillator/MRPC):
Time resolution: **80ps** (barrel)
60ps (endcaps)

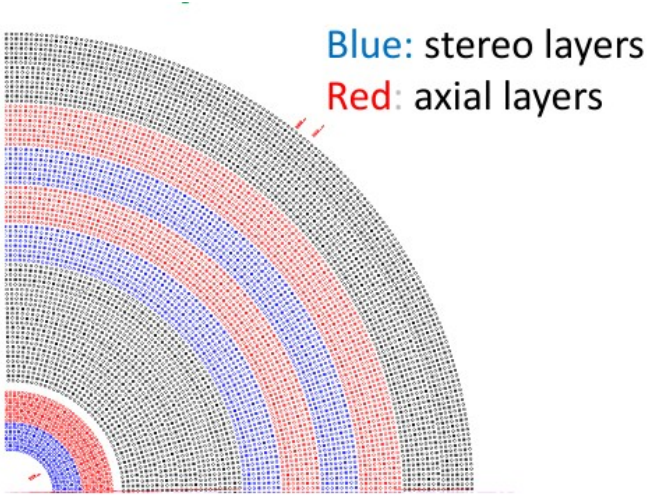
EMC: CsI cristal
- Energy resolution: **2.5% @1GeV**
- Spatial resolution: **6mm**

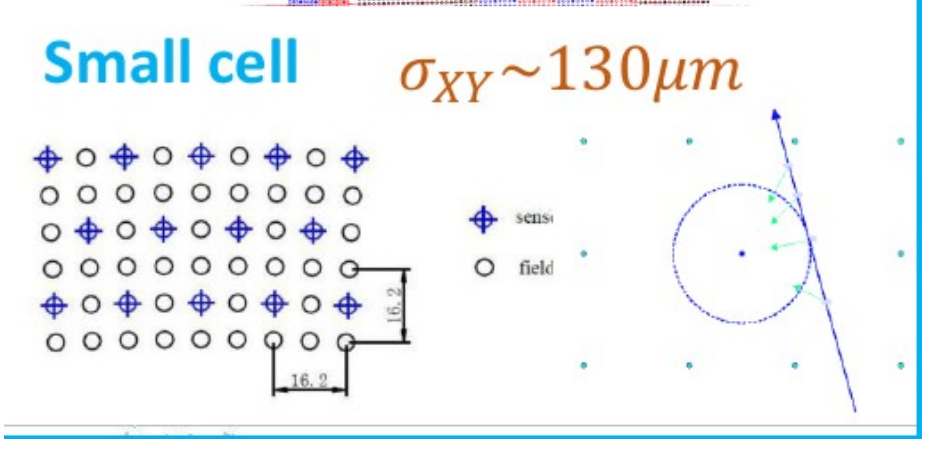
Muon ID:
9 layers RPC (8 for endcaps) in the flux-return yoke

BESIII Main Drift Chamber

Geometric parameters of the wire layers

Items		Parameters
Radius of inner most field wire		73 mm
Radius of outer most field wire		789 mm
θ-coverage: inner most layer		$\lvert\cos\theta\rvert \le 0.93$
θ-coverage: outer most layer		$\lvert\cos\theta\rvert \le 0.83$
Layer No.	Superlayer No.	Tilted angle
1 - 4	1	U: -(3.0° – 3.3°)
5 - 8	2	V: +(3.4° –3.9°)
9 -20	3 - 5	A: 0°
21-24	6	U: -(2.4° – 2.8°)
25- 28	7	V: +(2.8° – 3.1°)
29 - 32	8	U: -(3.1° – 3.4°)
33 - 36	9	V: +(3.4° – 3.6°)
37 -43	10 - 11	A: 0°

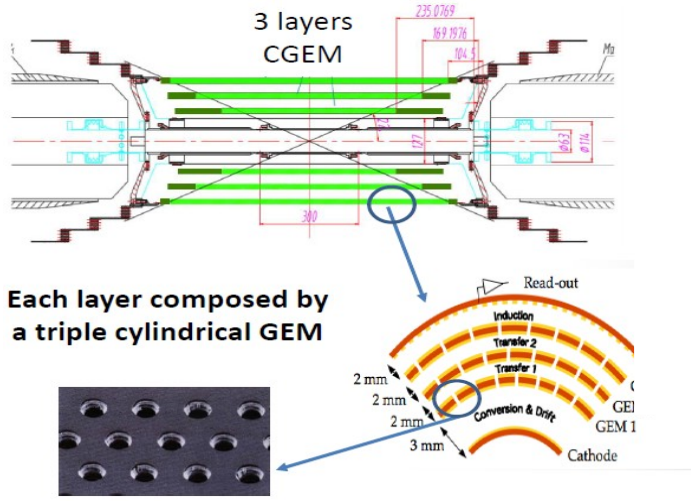




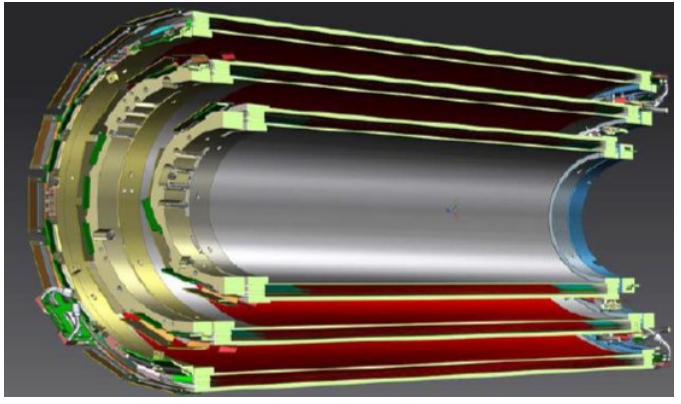
BESIII tracker upgrade

Inner part of the Main Drift Chamber suffered from aging and was replaced by a Cylindrical GEM in 2024

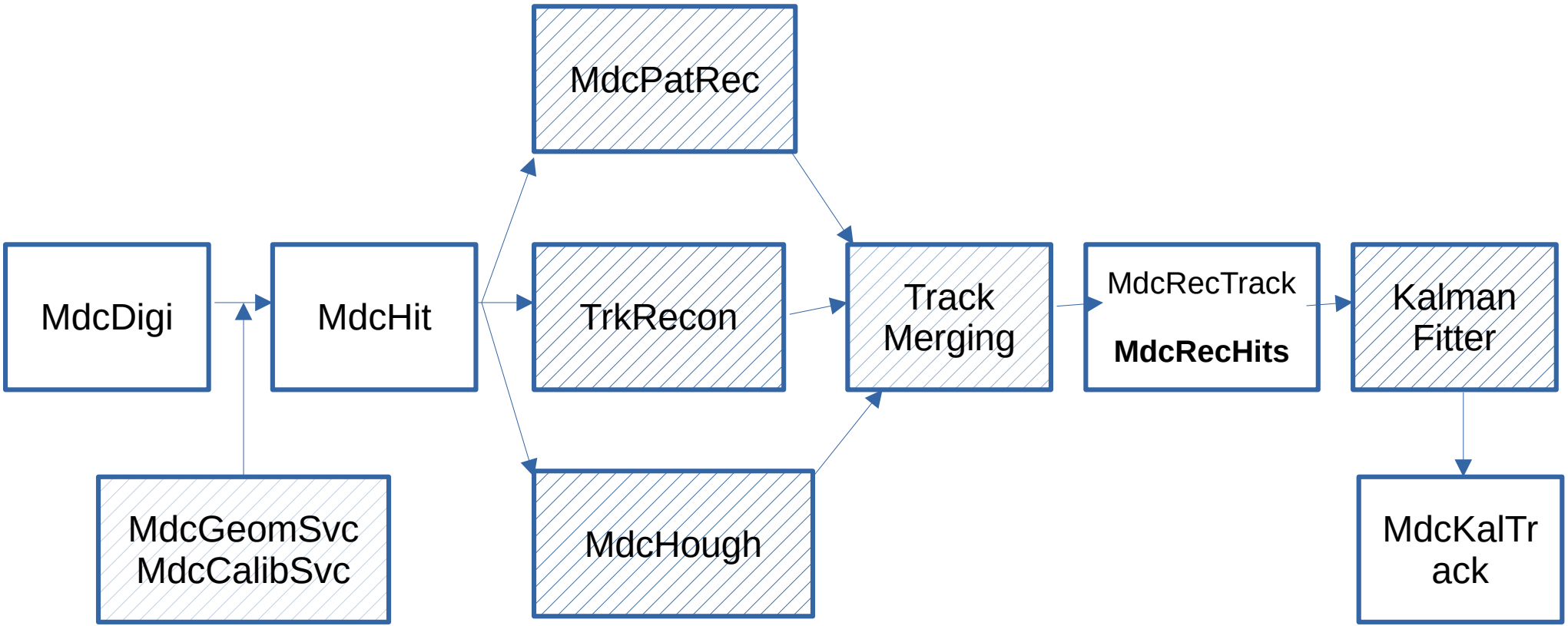
Similar to KLOE-2 CGEM



- Material <1.5%X_0
- Rate 10^4 Hz/cm^2
- $\sigma_{r\varphi}$ ~130 μm
- σ_p/p=0.5%@1GeV/c



BESIII tracking



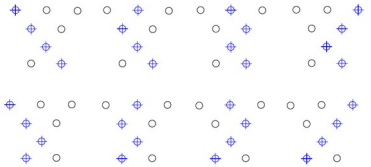
+ special methods for short and curly tracks

BESIII pattern recognition algorithms

- **MdcPatRec**

Re-used from BaBar

Based on looking for patterns in superlayers of four layers (dictionary of 20 patterns), followed by merging track segments



- **TrkRecon**

Re-sued from Belle

Local tracking based on seed finding and further corroborating using least squares method

- **MdcHough**

Developed at BESIII

A global method. Axial wires are used for track finding after Hough transformation in X-Y plane, followed by Z determination using stereo wires.

Becomes the only pattern recognition method since 2025 (together with CGEM)

Few words about ACTS

- ACTS was designed and developed for ATLAS ITS
- ACTS uses space points as input and Kalman filter for extrapolation and track fitting
- Geometry optimization in ACTS makes the Kalman filter much faster
- Spacepoints make it suitable for tracking in pixel detectors, TPC, strip detectors… - all detectors where it is easy to reconstruct space points
- Not suitable for drift detectors — no space points and no easy way to reconstruct from drift time and wire geometry

SPD possibly can use ACTS for track fitting, but not for track finding!

Of course, we can also invest into the ACTS developments and implement drift detectors there…

Conclusion

- SPD tracker system (straw tracker and MM) has clear similarity with Drift Chamber based experiments (e.g. BESIII, BELLE, KLOE, BaBar, CLEO, TOPAZ, VENUS, JADE, ARES etc), and not with the LHC experiments
- BESIII tracker (MDC+CGEM) is pretty similar to SPD's one (Straw+MM)
- To my mind, it makes sense to prototype SPD track finding using BESIII-inspired algorithms. The most interesting and promising one is MdcHough
- Kalman filter should be used for final fitting to save time
- We have a choice of possible solutions for Kalman filter (ACTS, GenFit, …, of course, DIY as well)